

AN ASSESSMENT OF X-RAY PELVIMETRY
IN SOUTH WEST SCOTLAND

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THESIS FOR THE DEGREE OF DOCTOR OF MEDICINE.

BY,

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Scope of the Present Investigation.

X-Ray Pelvimetry:-

The films of 2,000 unselected and consecutive patients between 1952 and 1956 were reviewed in order to ascertain:-

- (1) The incidence of contracted pelvis as evidenced by a diminution below 10 cms. in the antero-posterior diameters of inlet or outlet measured on a lateral pelvic film.
- (2) The variation in pelvic dimensions between social groups.
- (3) The significance of the pubo-vertebral angle in relation to the engagement of the foetal head at term.
- (4) If any after effects of radiation on the foetus could be found in the follow up histories of the children concerned in 5,070 post X-ray pelvimetry cases.

Material:-

Patients in the series were domiciled in the Counties of Dumfries, Kirkcudbright and Wigtown.
All/

All primigravid patients attending the Ante-Natal Clinics of Cresswell Maternity Hospital, Dumfries, had X-ray pelvimetry carried out as a routine procedure. Between the years 1945 and 1951 brim, lateral and outlet views were taken and after April, 1951, due to a national shortage of film stocks, pelvimetry investigation was restricted to a single lateral view and only if the measurements thus obtained were diminished, were further views carried out.

Because of the previous dystocia, still-birth or instrumental delivery eighteen parous patients were included, of whom **three** showed evidence of contracted pelvis.

X-Ray Pelvimetry Technique.

Lateral View:-

The patient stands with her bi-trochanteric plane at the true right angle to the film cassette, this being ensured by resting her anterior superior iliac spines on rubber pads projecting from the side of a Phillips pedestal Bucky in the vertical position. A brass isometric rod is placed in the natal cleft, in the plane of the antero-posterior diameters of the pelvis. The tube is centred over the upper posterior angle of the greater trochanter of the femur at a distance of 120 cms. from the film.

Brim View:- (Albert).

The patient sits back against a support so that the trunk is at an angle of 60° to the limbs (i.e. the horizontal). The pelvis brim is parallel to the film when the top of the symphysis pubis and the spine of the fourth lumbar are on the same horizontal plane. An aluminium wedge is placed under the anterior pelvis to prevent over-exposure of this portion of the film, as a longer exposure time is necessary to give an adequate picture of the posterior part of the pelvis. The isometric/

isometric rod is placed across the pubis and the tube is centred 5 cms. behind the symphysis at a distance of 100 cms. from the film.

OUTLET VIEW:- (Chassard and Lapine).

The patient is seated on a pedestal Bucky with the thighs abducted and the trunk flexed at the hip joints so that the head is between the knees. The aluminium wedge is placed under the buttocks and the tube is centred over the lower sacrum 100 cms. from the film.

On the 2,000 lateral films so obtained the following measurements and assessments were made:-

The antero-posterior diameter of the inlet, or more correctly, the obstetric conjugate, was measured from the promontory of the sacrum to the eminence at the back of the upper portion of the symphysis pubis. The antero-posterior diameter of the outlet, or plane of least pelvic dimensions, was measured from the tip of the last sacral vertebra to the lower border of the symphysis pubis.

The pubo-vertebral angle was measured between the plane of the pelvic brim and the plane of the anterior or ventral surface of the fifth lumbar vertebra.

The shape and length of the sacrum was assessed and cases where the sacrum showed loss of normal concavity were noted.

Environment, nutrition and heredity all take part in the formation and shaping of the female pelvis.

The series was divided into two broad economic groups according to the bed (Section 3, 4 or 5) occupied by the patient. Apart from type of accommodation provided, there is no medical nursing or dietetic differentiation between general and private ward patients and in cases where the medical condition requires single room accommodation this is provided for Section 3 patients.

Section 4 and 5 patients are grouped together for this series which, therefore, is divided into two groups, "General" and "Amenity", the total in each group being approximately equal. Comparisons were made between the distribution of pelvic size and the incidence of contracted pelvis in each group.

Following a recent article by Stewart and Giles (24) suggesting a possibility of radiation damage to the foetus following X-Ray of the mother during pregnancy, the children of these pregnancies during which X-Ray pelvimetry was carried out, were followed/

(Foot Note.)

National Health Service Act
(Scotland) 1947 .

Section 3:- (General Ward) - Patients for whom hospital accommodation is provided free of charge.

Section 4:- (Amenity Bed) - Patients who pay a proportion of the cost of the hospital bed.

Section 5:- (Amenity Bed) - Patients who pay the full cost of their hospital accommodation.

followed up with regard to their present health, previous illnesses and if they had died, the cause of death. Realising the rarity of leukaemia and malignant diseases in children and also the time interval which may elapse before the occurrence of these diseases, the enquiry was extended to cover all the patients who had X-ray pelvimetry carried out during pregnancy and were delivered in Cresswell Maternity Hospital between 1945 and 1956. This extension brought the total to 5,070 and the follow-up extended from 1 to 12 years.

All cases where children were certified as dying from malignant disease in the three counties, notified to the Medical Officer of Health, were checked for a record of X-ray pelvimetry during that particular pregnancy. Local Medical Practitioners were questioned as to any possible malignancy in children in their practice and retrospective search made in the records.

TABLE 1.Distribution of Antero-posterior Diameters of the Pelvis.

	<u>Inlet.</u>	<u>Outlet.</u>
8.0 - 8.4	1	1
8.5 - 8.9	3	2
9.0 - 9.4	17	9
9.5 - 9.9	29	28
10.0 - 10.4	122	137
10.5 - 10.9	242	254
11.0 - 11.4	375	389
11.5 - 11.9	403	409
12.0 - 12.4	377	382
12.5 - 12.9	257	205.
13.0 - 13.4	97	102.
13.5 - 13.9	54	57
14.0 - 14.4	23	23
14.5 - 14.9	-	-
15.0 - 15.9	-	2
	2,000	2,000

Average inlet A.P. - 11.5 cms.

Average outlet A.P. - 11.4 cms.

RESULTS.

The distribution of the antero-posterior dimensions of the pelvic inlet and outlet of the 2,000 patients is shown in Table 1. The average true conjugate was 11.5 cms. and the antero-posterior diameter of the outlet 11.4 cms. The majority had measurements between 10.5 cms. and 13 cms., the percentage of the total inlet measurements being 79.5% and of the outlet 81.9%. The smallest inlet measurement was 8.2 cms. and the smallest outlet 9.3 cms.

Those patients with an antero-posterior diameter, inlet and outlet, between 10 and 10.5 cms. are considered to be in the lower limit of normal or in the category of the slight pelvic contraction. 122 inlet cases (6.1%) and 137 outlet cases (6.9%) occurred in this group. Measurements below 10 cms. are considered evidence of the definite pelvic contraction and Table 1 shows that 50 cases (2.5%) had a contracted inlet and 40 cases (2%) had a contracted outlet. 4 cases (0.2%) had a generally contracted pelvis.

Where the measurements were above 13 cms. no cephalopelvic disproportion was encountered with an average size of child and in this category the inlet group numbered 174 (8.7%) and the outlet group 182 (9.1%).

Morphological Classification:-

All cases which showed evidence of contracted /

contracted inlet had further X-ray examinations of the brim of the pelvis, to determine the morphological classification. Brim shape is classified into gynaecoid, platypelloid and dolichopellic by means of measuring the antero-posterior and the widest available transverse diameter and calculating the brim index which is the ratio of the antero-posterior to the transverse diameter expressed as a percentage.

Gynaecoid - 81% to 99%.

Platypelloid - 80% or less.

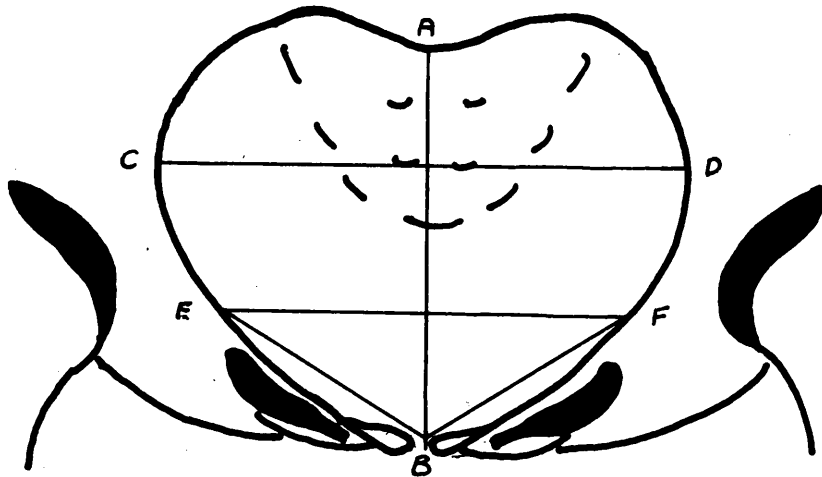
Dolichopellic - 100% or more.

Also the posterior sagittal index is calculated by estimating the percentage ratio of the portion of the antero-posterior diameter behind the widest available transverse diameter to the transverse diameter.

Where the posterior sagittal index is less than 30% the prefix "andro" is added to the above types to describe the restricted space in the posterior segment.

	<u>Brim Index</u>	<u>Post Agittal Index.</u>
Androplatypelloid.	80% or less.	30% or less.
Androgynaecoid.	81% to 99%	30% or less.

THE ANGLE OF THE FORE-PELVIS.



This angle is measured by first dividing the anterior sagittal diameter A-B on the brim view film into three equal parts and at the junction of the middle and anterior thirds a line E-F is drawn parallel to the transverse diameter C-D to meet the superior pubic rami. From the points of intersection of this line with the superior pubic rami lines are drawn to the symphysis pubis and the angle E-B-F contained by these lines is the angle of the fore-pelvis.

After fore-pelvis assessment of over 100 brim pictures an angle of 114° or less was considered ANDROID.

The android shape of brim has to show a posterior sagittal index of less than 30% and, in addition, an angle of the fore-pelvis of less than 114° . This type is exceedingly rare and none occurred in the present series.

TABLE 2.

BrimShape in 50 Cases of Contracted
True Conjugate.

Androgynaecoid	7
Gynaecoid	15
Androplatypelloid	15
Platypelloid	13
	—
	50
	==

As the group in Table 2 is selected by the discovery /

discovery of a contracted true conjugate on the lateral film it does not show the general trend of pelvic brim shape in the population under review, but shows the predominance of the flat pelvis, the platypelloid type, among the cases with a contracted pelvic brim - 56% against 44% with the gynaecoid brim.

Subpubic Angle:-

Where the antero-posterior diameter of the outlet measured 10 cms. or less an X-ray was taken to determine the subpubic angle (Chassard and Lapine).

TABLE 3.

	<u>Col.1.</u>	<u>Col. 2.</u>	
<u>S.P.A.</u>	<u>With contracted Outlet.</u>	<u>All Cases.</u>	
65 - 69	1	1	
70- 74	1	9	
75 - 79	7	14	Average with C.P. = 83
80 - 84	5	15	
85 - 89	19	31	Average all cases = 82.7
90 - 94	6	5	
95 - 100	-	1	
100 - 104	1	2	
Total	40	78	

Column 1 shows the distribution of the subpubic angle among cases with a contracted outlet conjugate and column 2 the distribution of all cases in which the subpubic angle was measured radiographically.

- (a) for reasons of contracted antero-posterior of the outlet.
- (b) where clinical assessment suggested a narrow subpubic angle.
- (c) where difficult low cavity forceps had occurred.

The narrowest angle recorded was 68° and the widest 102° , the latter in a patient with a generally contracted pelvis associated with congenital bilateral dislocation of the hips. The average angle in the first column is 83° with 65% of them more than 85° . Over all the cases where the angle was measured the average was 82.7° and 50% were more than 85° .

Patients with a generally contracted pelvic brim i.e. with an inlet and outlet antero-posterior measurement less than 10 cms. were only four in number (0.2%), of which two had a gynaecoid brim and two androplatypelloid.

Table 4 shows the brim and posterior sagittal indices of these cases.

TABLE 4.

General Contracted Pelves.

	<u>Brim.</u>	<u>Brim Index.</u>	<u>P.S.I.</u>	<u>S.P.A.</u>
1. Gynaecoid		87%	39%	80
2. Gynaecoid.		82%	32%	85
3. Androplatypelloid C.D.D.		76.5%	27%	102
4. Androplatypelloid		79%	27.5%	89

Other points noted in the review were:-

- (1) An **absence** of sacral concavity in 46, in which the sacrum lay parallel to a ruler laid alongside it on the radiograph and two had a convex sacrum.
- (2) Shallow pelves were found in 9 (3%) of the 300 measured where the sacrum was less than 9 cms. in length.
- (3) Congenital dislocation of the hips occurred in two cases, one with all measurements within normal limits and a gynaecoid brim, and the other was noted among the generally contracted pelves.
- (4) Spondylolisthesis, which was noted in one case, was **symptomless** and did not interfere with delivery.

TABLE 5.

Distribution of Antero-posterior Diameters
according to Social Groups.

<u>Inlet.</u>			<u>Outlet.</u>		
Cms.	General.	Amenity	General	Amenity	
8.0 - 8.4	1	0	0	1	
8.5 -8.9	2	1	2	0	"General "
9.0-9.4	11	6	7	2	Average Inlet 11.4 cms.
9.5-9.9	19	10	19	9	Average Outlet 11.5 cms.
10.0-10.4	63	49	60	67	
10.5-10.9	125	108	130	104	
11.0-11.9	212	153	178	201.	"Amenity"
11.5 -11.9	184	209	214	185	Average Inlet 11.6 cms.
12.0-12.4	168	189	174	188	Average Outlet 11.5 cms.
12.5-12.9	104	133	100	98	
13.0-13.4	48	49	40	61	
13.5-13.9	20	34	25	32	
14.0-14.4	8	15	16	7	
14.5-14.9	0	0	0	0	
15.0-15.4	0	0	1	1	
Total	965	956	965	956	

COMPARISON OF SOCIAL GROUPS.

Of the 2,000 patients under review 1,921 were delivered in Cresswell Maternity Hospital and the remaining 79 were delivered elsewhere.

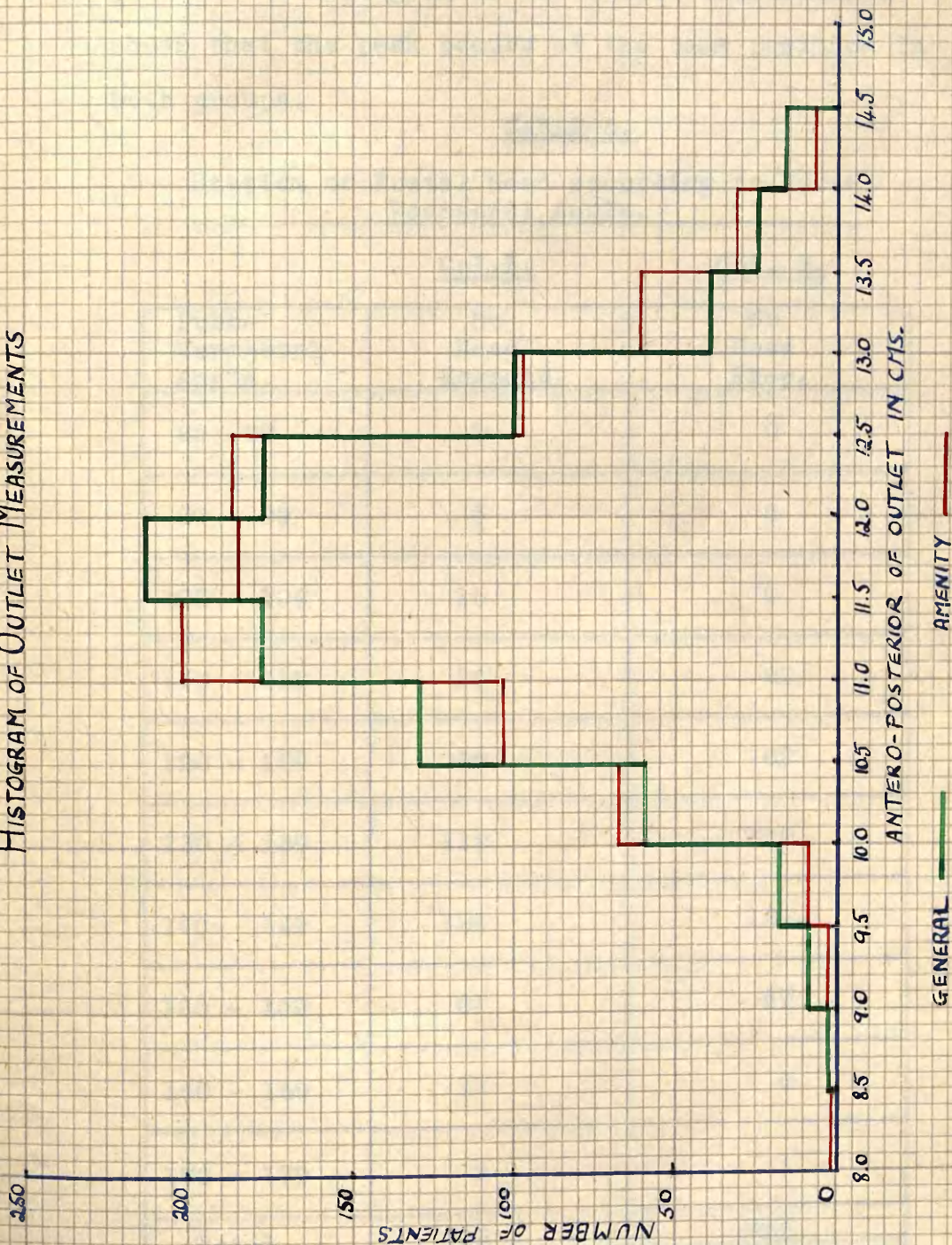
965 booked a general ward bed and 956 an amenity bed for their confinement. Table 5 shows the distribution of the pelvic measurements subdivided into the two social groups previously defined. In general patients the average measurement of the true conjugate was 11.4 cms. and the average outlet antero-posterior measurement was 11.5cms. In amenity patients the average true conjugate was 11.6 cms. and the average outlet antero-posterior was 11.5 cms.

The incidence of contracted inlet, i.e., less than 10 cms. in the general patients was 3.4% compared to 1.8% in amenity patients and the incidence of contracted outlet was 2.9% compared to 1.2%.

In the category of slightly contracted pelvic inlet, between 10 and 10.5 cms., the incidence is 6.5% for general and 5.1% for amenity patients. Similarly for the outlet antero-posterior measurement of 10.0 - 10.5 cms. the percentage for both general and amenity are approximately equal, being 6.2% and 7% respectively.

The frequency of observation of the measurements/

HISTOGRAM OF OUTLET MEASUREMENTS



observations of the measurements have been displayed in the histograms and it shows that the peak incidence of general cases lies half a centimetre below the peak of the amenity cases.

A histogram of the outlet measurements shows that the peak occurs at the same position in both groups.

TABLE 6.

Station of Foetal Head according to Pubo-Vertebral Angle.

	<u>Col.1.</u>	<u>Col. 2.</u>
Pubo-Vertebral Angle.	No Head Engaged.	No Head Free.
85 -89	2	0
90 - 99	3	6
100 - 109	15	9
110 - 119	24	22
120 - 129	45	62
130 - 139	112	112
140- 149	124	121.
150 - 159	61	67
160 - 169	17	6
170 - 179	3	1
Total	406	406

Table 6 shows the distribution of the pubo-vertebral angle of two groups of patients.

(a) Column 1:- An unselected random series with the foetal head noted as engaged after the 36th week of pregnancy.

(b) Column 2:- All cases in the series where the foetal head was free after the 38th week of pregnancy and before the onset of labour.

Between 100° and 160° the observed incidence is the same in both groups. Below 110° there are slightly more with the head engaged than those with the head free, 4.9% as against 3.7% but at the other end of the scale in the range over 160° it was found that 4.9% had the foetal head engaged as opposed to 1.7% with the head free.

POSSIBLE RADIATION EFFECTS.

Of the 5,070 deliveries resulting in 5,089 children born (twins - 19) 172 children were still-born and 92 died during the neo-natal period. Table 7 shows the causes of death.

The 4,806 mothers who left hospital with their children alive and well were asked to complete a simple form of enquiry into the child's health, any illnesses, hospital attendances and, if the child had died, the name of the doctor attending the child during the last illness. To avoid any possible domestic upset the children of 65 unmarried girls were investigated by the Lady Almoner of the hospital.

2,869 children were traced, 1,002 letters were returned as "address unknown" and the remainder did not reply. 26 children and 5 mothers had died.(Table 8).

TABLE. 7.

Causes of Perinatal Mortality.

Still-Births.		Neonatal Deaths.	
Congenital Abnormalities.	30	Congenital Abnormalities.	17
Accidental Haemorrhage.	20	Prematurity.	46
Birth Trauma.	9	Intracranial Haemorrhage.	12
Prolapsed Cord.	8	Atelectasis.	13
Cerebral Haemorrhage.	6	Infection.	3
Infection.	1	Erythroblastosis.	1
Prematurity.	7		
Erythroblastosis.	1		
Causes unknown.	90		
Total	172		92

TABLE 8.
Causes of Death.

Children.	
1. Orbital Neuroblastoma	8. Congenital Heart Disease.
2. Reticulum Sarcoma.	9. Multiple congenital abnormality.
3. "Leukaemia".	10. Coeliac disease.
4. Bronchopneumonia (6)	11. Pyloric Stenosis.
5. Gastroenteritis (3)	12. Road Accidents (2 cases).
6. Meningitis (3)	13. Air Crash.
7. Virus pneumonia.	14. Tetanus.
	15. Suffocated by bedclothes.
Mothers.	
1. Cancer of uterine cervix.	
2. Chordoma.	
3. Prolonged labour. Bronchopneumonia.	
4. Heart disease-mitral stenosis.	
5. Air Crash.	

The Medical Officers of Health of Dumfries, Kirkcudbright and Wigtown supplied the names of children who had died of Leukaemia and malignant disease in these Counties since 1945 and these totalled 14, all under 10 years of age. One child in Dumfries-shire, still alive, suffers from chronic myeloid leukaemia. There was no record of any of these mothers having been X-rayed during the particular pregnancy when the child had subsequently died or developed leukaemia or malignant disease.

One case certified as dying from leukaemia is included in both groups, No.3 of Table 8. There was no haematological or post mortem examination of the child who was seen by the certifying practitioner after death. Therefore, the cause of death should be grouped as unknown.

REVIEW OF LITERATURE.

The use of radiography for mensuration of the female pelvis has been carried out for the past forty years and during this time varying techniques have been used to assess pelvic capacity and as a means of forecasting the likely type of labour and method of delivery.

Caldwell and Molloy (5) used a stereoscopic method for the estimation of pelvic dimensions and shape and /

and adapted classification of the pelvis into four morphological groups, android, gynaecoid, platypelloid and anthropoid. The classification was complicated by the inclusion of sub-groups to include minor variations in pelvic shape and the faculty of stereoscopic vision is limited or absent in a few individuals. The stereoscopic apparatus is expensive and space occupying and for this reason the method did not gain wide acceptance. Other methods of classification by mathematical ratio stemming from the classical survey of the actual pelvis carried out by Turner (27) in 1886 were found to be more easily applied by the majority of workers in this field.

Nicholson (19) from pelvimetry films compared the pelvic brim area in 350 women from a rural district, using the formula $\frac{\pi}{4} a.b.$ to calculate the area of brim as an ellipse, where "2a" was the anteroposterior and "2b" the transverse diameter. He preferred the simpler classification of pelvic type:- flat, narrow and average and found that the shape and size of the brim was not related to the shape and size of the outlet.

Chassor Moir (17) developed a graphical method/

method of forecasting the outcome of labour and combined it with experience of previous deliveries to detect those cases in which difficulty might be anticipated.

Rohan Williams and Arthure (29) superimposed the actual dimensions of the pelvis, lateral and brim views, on a prepared chart on which was further superimposed a disc 9.3 cms. in diameter, the size estimated for the foetal skull, and thereby claimed an accurate forecast rate of over 80%.

Thoms (26) perfected a radiographic technique to show brim and lateral views, and the grid method of measurement, and compared the pelvic shapes and dimensions between different races and between social classes. The "mesatipellic" and brachipellic "pelves were the most common types in general and the "dolichopellic" pelvis was predominant in the higher social classes. The " platypellic" group, being associated with diminished dimensions, contained the highest incidence of operative deliveries.

Similar investigations were carried out by Hastings, Ince and Young (12) in a comprehensive statistical analysis of the inter-relationship of pelvic architectural characteristics, the external physical characters /

characters of the patients and difficulties experienced in labour. In their review of 500 primigravid and multiparous women these authors revealed a repetitive error which had persisted in many of the then current textbooks of under-estimating the true conjugate. It was shown that the external measurements of the pelvis and the diagonal conjugate can only be related to the internal true measurements as a general rule and are not reliable in each individual patient. They condemned as unscientific the subjective impressions of Caldwell and Molloy and they stated that the relationship between varying pairs of pelvic characteristic was insignificant except between inlet and outlet anteroposterior measurements. Body build and the presence of hirsutism were found to bear no relation to android shape of pelvis. The A.P. diameter of the outlet and subpubic angle had influence on the incidence of forceps deliveries.

Kenny (13) reviewed a thousand selected primigravidae and multiparae where X-ray pelvimetry had been carried out because clinical assessment had suggested pelvic contraction or where there was a history of dystocia. She maintained that the shape of the pelvis was of more importance in forecasting the course of labour than the actual dimensions and declared that the android pelvis was /

was related to a higher incidence of menstrual irregularities, infertility, pre-eclampsia, dystocia and puerperal morbidity than any other morphological group. The patient with a gynaecoid pelvis was more often subject to pelvic arthropathy due to a possible increased sensitivity to normal amounts of the hormone "relaxin". An interesting revelation in the possible inheritance of pelvic shape was shown by the similarity noted between the shape of the female foetal pelvic brim and the maternal pelvic brim.

In a small series of twenty which were investigated thirteen showed a similar brim outline to their mothers. This relationship was not found among male children.

Similar to Hastings, Ince and Young, Kenny maintained that the external measurements were useless and even the diagonal conjugate was misleading, as a false impression of pelvic adequacy may be assumed when the promontory of the sacrum is not reached by vaginal examination at the 36th week.

In Modern Trends in Obstetrics and Gynaecology O.S. Heynes received past ideas of pelvic development and cast doubts on the production of abnormal pelvic shape being caused by undernutrition, notably rickets. He proposed a "realistic hypothesis to follow antogenetic development of the form of the pelvis". By his reasoning on the growth/

growth of the pelvic bones from the acetabular Y shaped, symphyseal and sacroiliac epiphyses, and study of comparative anatomy, the short true conjugate and narrow posterior segment resulted from poor and angular growth at these epiphyses. He concluded that genetic make-up and hormonal balance, together with general somatic build had more control of the pelvic shape than nutrition.

Stewart and others reported a trend of increased likelihood of a child to develop malignant disease following irradiation in utero in a preliminary report in 1956. In the further survey Stewart and her colleagues finally concluded that foetal irradiation does not account for the recent increase in childhood malignancies.

and over the period of 1950-1959 the population of the
irradiated district. The population of the
district was 10,000 in 1950 and 10,500 in 1959.
The district was a fairly rural, agricultural district
within the county of Suffolk, with a population of
10,000.

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10,000. The district was a fairly rural, agricultural district
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10,000.

DISCUSSION.

The average obstetric conjugate of 11.5 cms. obtained in this series is comparable to that obtained by Nicholson, Ince and Young and Chassar Moir.

Radiographic Measurement of Pelvis.

	Nicholson	Ince & Young.	Chassar Moir	Present Series.
Obstetric Conjugate.	11.6	11.8	11.2	11.5
Antero-posterior of Outlet.	13.0	12.0	11.4	11.4

Maguire (16) quotes a lower figure of 11 cms. as the average true conjugate. The population from which Chassar Moir and Nicholson drew their cases was rural and the series of Ince and Young was drawn from Metropolitan London. The population (146,000) of the present series is mainly rural, the largest town being the county town of Dumfries, with a population of 30,000.

The average outlet measurement of 11.4 cms. is the same as found by Chassar Moir but less than that quoted by others. The end points stated by these three authors are the same as are used in this series.

Maguire/

Maguire does not give an average figure for the outlet antero-posterior but states that it varies between 9.8 and 11.5 cms. Movement of the pelvic bones and softening of the pelvic ligaments cause variation in the outlet measurement and Weinberg (28) has shown that the increase in outlet diameter may be from 1 to 1.5 cms. near term.

The main purpose of X-ray pelvimetry is to detect pelvic contraction and an incidence of 2.5% contracted inlet and 2% contracted outlet was found in this group of patients.

Generally contracted pelvis was uncommon, occurring in four cases (0.2%), only two of whom were under 5 feet in height and one having bilateral congenital dislocation of the hips. In all, three cases of congenital abnormality affecting the pelvis were found, two of congenital dislocation of the hip, of whom one had normal pelvic measurements and one of spondylolisthesis.

Factors Influencing Pelvic Shape:-

As could be expected from the mechanics concerned in pelvic development, the platypelloid type was more common among the brim contraction group.

The foetal pelvis may begin to adopt a definite morphological type during intra-uterine life, when hereditary factors control the brim shape, Kenny reporting/

reporting a series of 20 in which 13 female foetuses had a similar brim outline to their mothers. According to Maguire, however, the foetal pelvis tends to be funnel shaped.

In early childhood environment and nutrition play a significant part in determining pelvic shape, malformations being due to a deficiency of calcium and vitamin D associated with a lack of sunlight and a poorly balanced diet, notably characterised by the rachitic flat pelvis. These deficiencies cause softening of the pelvic bones and before walking begins the child's weight, transmitted through the spine, presses down on the sacrum, pushing it towards the symphysis pubis and the ischial tuberosities are splayed out. The extreme form of rachitic flat pelvis is exceedingly rare now-a-days but minor deficiencies causing "masked " rickets without the outward signs of malnutrition are not revealed on external examination. These minor forms of deficiency lead to a narrowing of the obstetric conjugate and this is more common among the General patients where the incidence of contracted pelvic inlet is 3.4% compared to 1.8% in the Amenity group. A proportion of this higher incidence may be due to heredity and Baird (2) has shown that the interchange between social groups by marriage usually cancels itself out by an almost equal /

equal number of women moving from one social group to another.

In the later years of childhood the deficiency of calcium and vitamin D causes a different kind of deformity of the pelvis as the femoral heads press inwards compressing the lateral pelvis walls and producing the funnel pelvis.

Thoms and Nicholson maintain that the size and shape of the pelvis is largely dependent on the diet during adolescence and this is a reasonable hypothesis since the ossification of the pelvic bones is not complete until the 25th year of life. The stresses and strains on the pelvis would be greater during active adolescence with rapid height and weight gain than in the comparatively inactive period of the first two years of life.

Hereditary factors controlling height and physical configuration play a part in the shaping of the pelvis but the relationship between height and body configuration and shape and size of the pelvis are so variable that, although small stature and hirsutism indicate a possibility of pelvic contraction and android configuration, it is by no means possible to pick out an individual patient under 5 feet in height and state, categorically, that that particular patient must have a contracted pelvis.

Kenny/

Kenny has shown that an android shape of pelvis is not invariably associated with the small hirsute woman. In a series of 40 Jewish women she found the gynaecoid brim in every case despite a variety of external appearances.

The fully developed female pelvis is the result of an interplay between heredity and racial factors initially controlling the basic shape and then throughout childhood and adolescence, the predominant control is nutritional, although to a lesser extent hormone influence is present. Rarely unilateral bone and joint disease alters the symmetry of the pelvic bones.

Comparison between the pelvic size of the social groups, General and Amenity, show that the average pelvic dimensions were approximately the same. The striking difference appears when comparing the incidence of contracted pelvis, both of inlet and outlet, which is much more common in the General group. Baird suggested that the higher perinatal mortality rate among the lower social groups is due, not only to poor nutrition and low standards of living during pregnancy, but also to such deficiencies being present throughout the mother's life and complicating labour and delivery by a higher incidence of pelvic contraction.

Pubo-Vertebral Angle:-

In order to discover if the tilt of the pelvis affected the engagement of the foetal head at term, the angle between the pelvic brim and the vertebrae was measured and the results are given in Table 6. The usual method of measuring the tilt of the pelvis is by taking the angle between the pelvic brim and the horizontal but the pubo-vertebral angle gives a better indication of the relationship of the pelvis to the maternal trunk. Davies (6) believes that man's erect posture was achieved by the extensor muscles of the back holding the trunk erect and that the pelvis maintains the quadruped relation to the horizontal. He points out that this affects the engagement of the foetal head at term, the delivery of the after-coming head in a breech delivery and the support of the uterus by the utero-sacral transverse cervical ligaments.

If the pubo-vertebral angle is near a right angle then the foetal head would more easily engage than if the angle is obtuse and nearer 180° .

Over a range of 50° with a pubo-vertebral angle between 110° and 160° there were 366 with the foetal head engaged and 384 with the head free. Of cases with the angle below 110° , 20 had the head engaged and 15 had the head free and where the angle was /

was more than 160° , 20 had the head engaged and 7 had the head free. Of the whole series only 406 were found with the foetal head free which confirms that foetal head engagement can be anticipated in primigravidae after the 36th week. but considering the pubo-vertebral angle alone, without taking into account other factors, such as occipito posterior position the angle does not appear to have much bearing on the station of the foetal head at term .

The Sub-pubic Angle:-

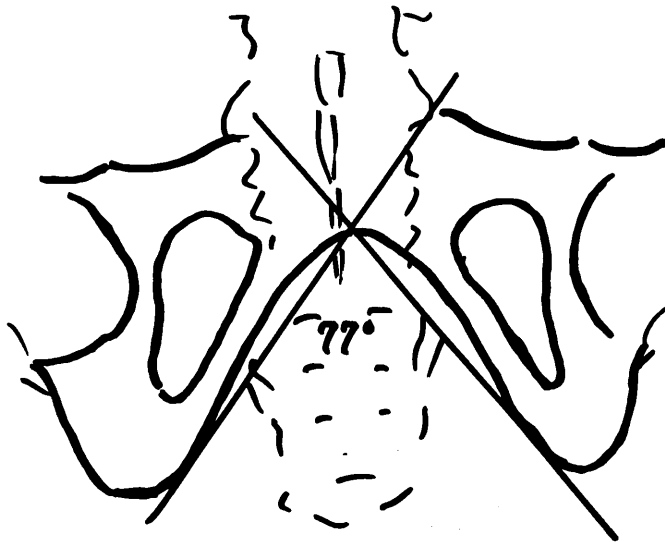
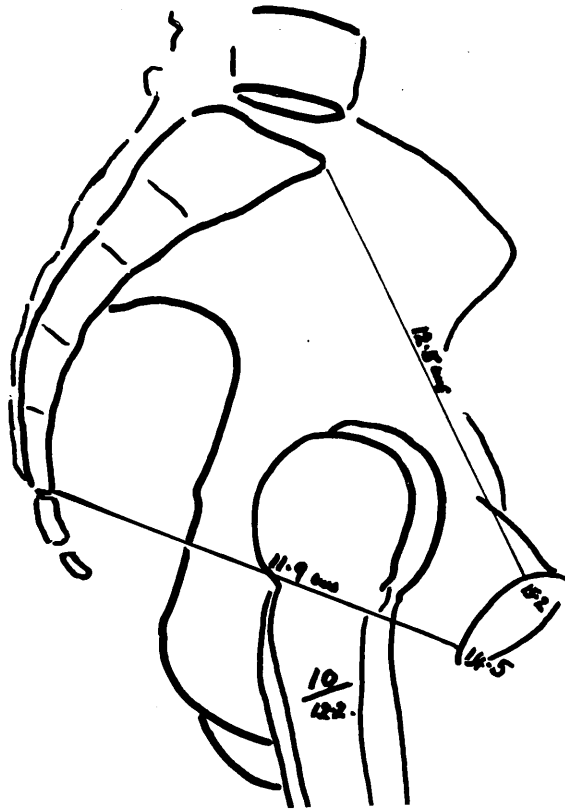
The average sub-pubic angle of 83° in the group with contracted outlet is very close to the average angle of 84.8° for all pelves in Nicholson's series of 350 primigravidae. An angle of 80° and over is unlikely to cause difficulty in delivery of the head where the antero-posterior of the outlet is adequate, but below 80° the head cannot be accommodated closely under the pubic arch and is, therefore, thrust backwards towards the sacrum.

Where the antero-posterior diameter of the outlet is adequate, as in "A", delivery can be accomplished by episiotomy to allow the head to escape near the sacrum.

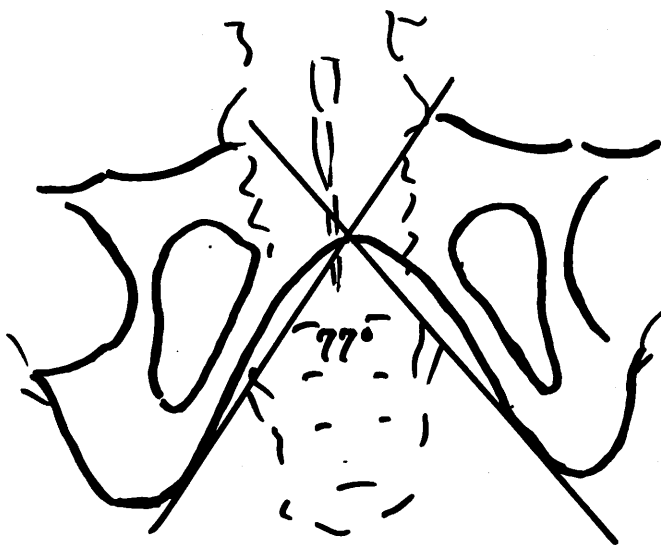
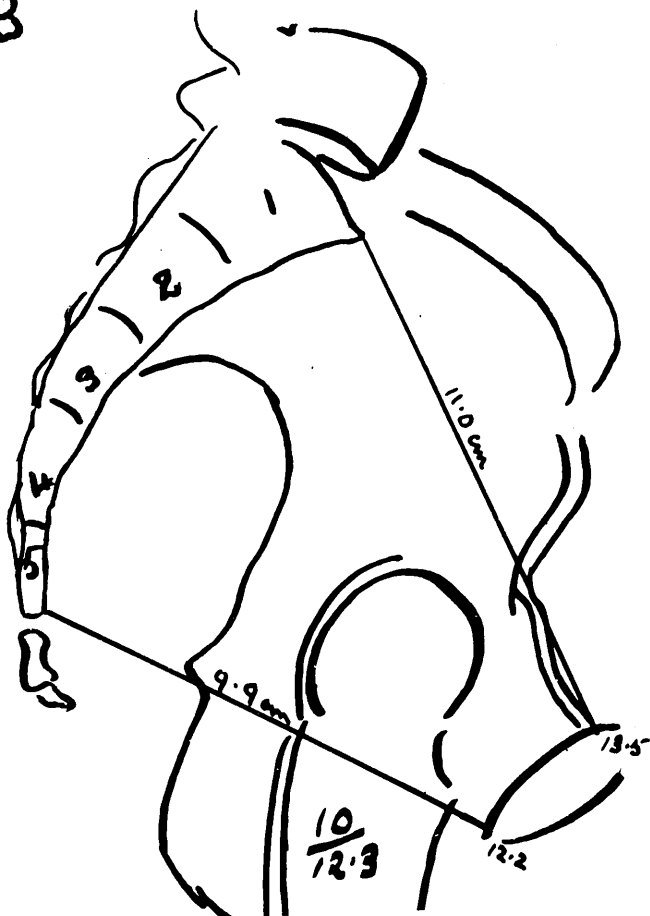
If the antero-posterior outlet diameter is contracted in "B" then marked dystocia would occur.

The /

A



B



The relaxation of the pelvic ligaments allows an increase of 1-1.5cms. in the outlet diameter and may afford compensation.

... of whom died or were deformed by the radiation from inadequately protected ...
In a recent article Scott Brown has shown ...
... of 1175 among British ...
... responsible in that of other physicians ...
... of the investigation.

It has been discovered that ...
from many different sources such as ...
... explosion fell out ...
and trapped ...
individuals ...
received ...
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...
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...

RADIATION HAZARDS.

The hazards of ionising radiation as used in medical diagnosis and treatment have been increasingly appreciated in recent years, partly due to the delayed reaction to radiation and partly to the limited knowledge of the effect of such radiation on human tissues.

Surface burning was soon discovered and later the development of malignant disease in the damaged tissue was noted and suffered by early X-ray workers, some of whom died or were deformed by the excessive radiation from inadequately protected equipment. In a recent article Court Brown has shown that expectation of life among British Radiologists is comparable to that of other physicians of this country, at the present time.

It has been discovered that radiation dosage from many different sources such as cosmic rays, nuclear weapon explosion fall out, medical diagnosis and treatment, may be additive throughout an individual's life and the summation of radiation received may result in injury to the recipient. It is known that the more immature the tissue the more liable it is to suffer damage from radiation.

Radiotherapeutic treatment of cancer of the uterine cervix has resulted in foetal abnormalities and death (21.) In the treatment of cancer the radiation dosage is high, being in the region of 2,000 to 4000r, much greater than the dosage used in diagnosis. An increased incidence of leukaemia is reported in the treatment of ankylosing spondylitis by radiation. A preliminary communication by Stewart and Giles (24) related the earlier results of a nation wide survey of children who had died of leukaemia and a comparison with a control group of children of similar age and sex. 85 of the mothers had received diagnostic radiation in the leukaemia group against 45 in the control group. There was no selection made for the parity of the mothers nor was the type of X-ray, abdominal or pelvimetry, stated. This preliminary report stimulated investigation from another point of view, the follow-up of mothers and children where the former had undergone X-ray pelvimetry.

With the constant movement of the population it was not possible to trace all of the children, and it is appreciated that there may be some cases of malignant disease among those who did not answer the questionnaire or those who had changed their domicile, but among the 2,868 children who were traced there were only two cases of malignant disease of such a rare type that it would

be impossible to prove that their occurrence was other than fortuitous. On the other hand, any one of the children who was certified as dying of bronchopneumonia may in fact have died of leukaemia a disease in which the terminal stages may simulate broncho-pneumonia. It has already been pointed out that the one death certified as leukaemia does not fulfil adequate criteria of accuracy as no haematological or post-mortem investigation had been carried out.

It is apparent that leukaemia is a rare condition among children and that the 2,868 children in the group investigated may be an insufficient number in which a case might reasonably be expected to occur and it is also realised that a control group of the same type of patients, i.e. primigravida, not X-rayed during pregnancy, is necessary for comparison with the group under review. Furthermore any one of these children may develop leukaemia in the next few years, especially from that portion of the group X-rayed in the later years of the series.

Nevertheless this review shows the extreme rarity of the condition. It has been suggested by Lewis that one possible X-ray induced leukaemia may occur in every 40,000 deliveries, and this means that in a hospital such as Cresswell Maternity Hospital where

an average of 1,600 births take place each year, if the preliminary deductions of Stewart are correct, one possible case of leukaemia induced by X-rays may occur every 27 years.

In a later article, Stewart and others have completed the survey of childhood malignancies and their final conclusion was that foetal irradiation in utero did not account for the recent increase in childhood malignancies but that the case excess in the affected group indicated restriction in the use of radiology for diagnosis in pregnancy.

Geneticists have studied the effect of radiation on the broad bean, (*Vicia Faba*) and on the *Drosophila* Fly and maintain that any increase of ionising radiation increases the normal rate of mutation in the genes, the normal rate being maintained by the background radiation from cosmic rays and radioactive substances in the atmosphere and the earth. It is said that a doubling of the mutation rate is achieved by radiation in the region of 30 to 80 r. during the reproductive period of life. Mutants on the whole tend to be recessive and to produce abnormalities and more rarely beneficial mutations occur. In man, according to some authorities, the spontaneous mutation rate is as high as his reproductive capacity can tolerate and that abnormal

mutants, such as diabetes mellitus being saved by medical treatment, have tipped the balance.

The amount of radiation received by the patient during X-ray pelvimetry, brim and lateral view was estimated as 0.47r by Martin Williams (29) and as 0.9r for the lateral film by Parlee (21). Stanford (22) maintains that the radiation dosage varies considerably between different departments and hospitals depending on the care taken by the radiologist and his consciousness of the dangers of overdosage.

In a personal communication from Dr. Lenihan, of the Western Regional Hospital Board Physics Department, he estimates the dosage received by patients at Cresswell Maternity Hospital to be comparable with the results shown above.

In this hospital adequate care is taken to reduce the radiation dosage by increase of the patient-tube distance, the use of filters and cones and reducing to a minimum the numbers of exposures necessary to achieve a satisfactory film.

Against the dangers of radiation must be balanced the advantages of an accurate pelvic measurement and the possible but unmeasurable saving in life by the early detection of pelvic abnormalities.

CONCLUSIONS.

1. The incidence of contracted pelvic inlet was 2.5% and contracted pelvic outlet 2%. Generally contracted pelvis is exceedingly rare. The average pelvic dimensions of the antero-posterior of the pelvis are similar to other rural populations in Great Britain.
2. Between difference social groups the average pelvic dimensions do not show a significant difference but the incidence of contracted pelvic inlet is still considerably higher in the lower social groups.
3. The pubo-vertebral angle, considered alone, does not appear to affect the station of foetal head at term in a primigravida.
4. Inviestigation of the children who had been irradiated in utero during X-ray pelvimetry revealed only two rare types of malignant disease. Apart from possible genetic effects as yet unproved in human beings, X-ray pelvimetry is unlikely to have endangered the children by an increase in the incidence of malignant disease.

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